Frequency and duty cycle modulation optimization in minimizing thermal accumulation effect in Z-scan measurement with high-repetition-rate laser

Abstract

In this study, we demonstrate the optimization of the chopper frequency and duty cycle in a Z-scan measurement with a 250 MHz high-repetition-rate (HRR) femtosecond laser to minimize the thermal lensing effect due to cumulative heating of the sample. The result shows that such minimization can be achieved by keeping the modulated exposure time on the sample shorter than the thermal diffusivity decay time tc. The minimum chopper frequency fmin is predicted by relating the duty cycle factor F with tc, while maintaining stable peak and valley transmittances, i.e., ΔTp and ΔTv, respectively. Furthermore, a lower fmin is obtained by taking a stable range of the peak–valley difference ΔTpv into consideration. The optimization allows for the low operational modulation frequency of Z-scan measurement with reduced thermal influence, thus enabling simple management of the thermal lensing effect.

Keyword: Chopper frequency; Duty cycle; Z-scan